

## **Sliding Door System for a Vehicle, especially for a Motor Vehicle with an Energy Guide Chain**

The object of the Patent Application refers to a sliding door system for a vehicle, especially for a motor vehicle, to a vehicle, especially a motor vehicle, as well as to an energy guide chain.

Sliding door systems for a vehicle, especially for a motor vehicle, have been known for a long time.

The motor vehicle can be a transport vehicle or a personal motor vehicle, which is also designated as van, minivan or microvan. Such a vehicle has at least one sliding door which is arranged so that it can be moved essentially in the longitudinal direction of the vehicle. For this purpose, the chassis of the vehicle has suitable guide means. These means can be roll guides in which rolls that are connected with the sliding door on an arm, are arranged. Roll guides for a sliding door, especially for motor vehicles, are known through DE 187 23 837 A1. In connection with the activation devices for a sliding door, especially for motor vehicles, reference is also made to the disclosure content of DE 198 06 762 A1.

Problems exist with regard to the energy supply of electrical users in a sliding door. The electrical user can be, for example, a loudspeaker, an electrically activatable window opener or electrically activatable closing mechanisms. This problem has already been known. Through EP1 010 558 A2, a sliding door system is known for a vehicle, especially for a motor vehicle, which had an energy guide chain which is connected at one end to the sliding door and at the other end to the chassis of the vehicle. Lines are guided in the energy guide chain from the chassis to the sliding door. The energy guide chain is designed so that it can be deflected sideways, so that the energy guide chain follows the nonstraight line movement of the sliding door during an opening or a closing process.

The energy guide chain is arranged in the bottom region of the chassis of the vehicle. For this purpose, it is necessary that sufficient space be available for building it in. This is not the case in all vehicles, so that subsequent equipment of a vehicle with an energy guide chain becomes very difficult.

Based on this, the goal of the present invention is to provide a sliding door system for a vehicle, especially for a motor vehicle, through which supply is made possible to users located in a sliding door, especially electrical users, even when the space is limited.

This goal is solved with a sliding door system for a vehicle, especially for a motor vehicle, with the characteristics of Claim 1. Advantageous further developments and embodiments of the sliding door system are the object of Claims 1 to 11.

The sliding door system according to the invention for a vehicle, especially for a motor vehicle, consists of at least one sliding door, which can be moved between a closed position and an open position. The system has at least one energy guide chain which can be connected with one end of the sliding door and with the other end to a chassis of the vehicle. The energy guide chain may contain a number of different lines, especially electrical lines, so that, for example, an electric user, which is arranged in the sliding door, is connected to an electrical system of the vehicle through an electrical line, which is guided in the energy guide chain. The energy guide chain has at least one curved region lying between the ends. The sliding door system according to the invention is characterized by the fact that, depending on the position of the sliding door, the curved region has different radii of curvature. Through this design of the sliding door system according to the invention, the possibility is created of adjusting the sliding door system to different vehicles. This is especially provided by the fact that then the energy guide chains can achieve very good adjustment to the existing spatial conditions. Therefore, there is also a possibility of equipping already existing vehicles with a sliding door with the sliding door system according to the invention.

According to an advantageous embodiment of the sliding door system, it is proposed that the area of curvature in the closed position have a radius of curvature which is different from the radius of curvature in the open position of the sliding door. Preferred is the design of a sliding door

system in which the radius of curvature in the closed position is smaller than the radius of curvature in the open position of the sliding door.

As a result of the fact that the radius of curvature depends on the position of the sliding door, the energy guide chain can follow the nonlinear movement of the sliding door. In the closed space, the sliding door has a curved region of the energy guide chain, preferably with the lowest value for the radius of curvature. In this position, the spatial requirement for the energy guide chain is very low. When the sliding door is opened in the longitudinal direction of the vehicle to the maximum state of opening, the energy guide chain follows the opening process in such a way that the radius of curvature is changing. Preferably, this radius of curvature increases, especially the radius of curvature reaches its maximum value in the open position of the sliding door. Through this measure, excessive stress on the energy guide chain is avoided. On the other hand, the energy guide chain preferably does not come in contact with the components on the surface of the vehicle chassis.

According to a still other advantageous embodiment of the sliding door system, it is proposed that the ratio of the radius of curvature in the closed state to the radius of curvature in the open state be smaller than 0.9, preferably smaller than 0.8, especially smaller than 0.5. At these values, we are dealing with preferred embodiments of the ratios of the radius of curvature in the closed position and the radius of curvature in the open position, but other values can also be possible and advantageous. This ratio can also be dependent on the available space conditions and/or on the construction of the chassis of a vehicle, as well as on the course movement of the opening process or closing process of the sliding door.

The change of the radius of curvature in the curved region, depending on the position of the sliding door, can be done continuously or discontinuously. Here, one can deal with an increase and/or decrease of the radius of curvature. In order to simplify the design of the sliding door system, it is proposed that the energy guide chain have at least two sections which are designed in such a way that, depending on the position of the sliding door, the curved region has different radii of curvature. Through this advantageous further development of the sliding door system, a simplified manufacture of it is achieved, since essentially one has to use two different chain link types.

The length of the sections can be different, especially if it is proposed that the ratio of the two sections to one another be smaller than 0.8, preferably smaller than 0.6, especially smaller than 0.5. Here, too, the ratio of the lengths of the sections can assume different values, where the number and the length of the sections are adjusted to the concrete embodiment of the vehicle in combination with the sliding door system.

The energy guide chain, which has the sliding door system, includes chain links which are connected to one another pivotably and where the chain links have stops for limiting the pivot angle and the chain links of the at least two sections have with differently designed stops. The radius of curvature in the curved region is determined by the stops.

Here, a design of the energy guide chain, with which the stops represent an integral component of the chain links, is preferred. In order to adjust the sliding door system to different cases of application, it is also proposed that the steps be connected to the chain links so that they can be separated.

According to still another advantageous embodiment of the sliding door system, it is proposed that the energy guide chain be movable in an essentially horizontal plane. Here, we are dealing with an essentially lying-down arrangement of the energy guide chain.

According to still another advantageous embodiment of the sliding door system according to the invention, it is proposed that the energy guide chain be at least partly designed from at least one plastic.

Furthermore, the goal of the invention is to provide a vehicle which has at least one sliding door system, where the design of the sliding door system should be achieved with simple means.

This goal is solved according to the invention with the characteristics of Claim 12.

Another goal of the invention is an energy guide chain with a multiplicity of pivotably linked chain links which form a curved region lying between a first trunk and a second trunk,

characterized by the fact that the curved region has different radii of curvature, depending on the movement path.

Other advantages and details are explained with the aid of the practical examples shown in the drawing, without limiting the object of the invention to the concrete practical examples.

The following are shown:

- Figure 1 shows schematically and in section a vehicle with a sliding door system in the closed state,
- Figure 2 shows schematically the sliding door system according to Figure 1 in the partially opened state, and
- Figure 3 shows the sliding system according to Figure 1 in the completely opened state.

The chassis 1 is designed so that it has a receptacle 4 for a sliding door 2. In the closed position of sliding door 2, as it is shown in Figure 1, the sliding door 2 penetrates into receptacle 4.

A carrier arm 3 is provided for holding and guiding sliding door 2. The carrier arm 3 extends essentially perpendicularly from the sliding door in the direction of receptacle 4. At its free end, carrier arm 3 has at least one guiding means, especially a roll 5. The roll 5 is guided within a guide, which is not shown, and which is connected with chassis 1. The sliding door 2 can have at least one other carrier arm, too, which is guided in a corresponding guide. This guide can be, for example, in the roof support on a sidewall of the vehicle. The receptacle 4 has a depth A, which is specific to the vehicle.

An energy guide chain 6 is arranged within receptacle 4. The energy guide chain 6 is connected with an end on a fixed point 7, which lies on chassis 1. The energy guide chain 6 is connected to the sliding door through a carrier 8.

The length of the energy guide chain 6 as well as the arrangement of carrier 8 on the sliding door 2 is chosen so that the sliding door 2 can be opened completely without the energy guide chain 6 hindering or limiting the opening process.

In the closed position of sliding door 2, as shown in Figure 1, the energy guide chain 6 has a curved region which has a radius of curvature  $KRX$ . During the opening process of the sliding door, it is removed from receptacle 4, and is shifted in the longitudinal direction of the vehicle chassis. During this process, the depth of receptacle 4 increases. Figure 2 shows a partially opened sliding door 2, where the depth of the receptacle 4 is designated with B. The depth B is greater than the depth A. The increase is dependent of the path of movement of sliding door 2 on the curved track of roll 5. With increasing degree of opening of the sliding door, the depth of the receptacle 4 increases. In the completely opened position of sliding door 2, as is shown in Figure 3, receptacle 4 has reached its depth C.

The energy guide chain 6 follows the movement of sliding door 2. Depending on the position of sliding door 2, the energy guide chain 6 has different radii of curvature. In the closed position, the curved region has a radius of curvature  $KRX$ . In the open position of sliding door 2, the radius of curvature is designated as  $KRY$ . These radii of curvature in the end positions of the sliding door are different. In the closed position, the radius of curvature  $KRX$  is smaller than the radius of curvature  $KRY$  in the open position of the sliding door.

For this purpose, the energy guide chain has at least two sections, which are designed so that, depending on the position of sliding door 2, the curved region has different radii of curvature. The ratio of the two sections lies in a preferred range of approximately 0.5 in the practical example shown.

With the present invention, the existing space of receptacle 4 is used for incorporating an energy guide chain 6, without additional measures being required for accommodating the energy guide chain 6 within the chassis or the sliding door. As a result of the fact that the energy guide chain is designed so that it has different radii of curvature depending on the position of the sliding door, it is ensured that the energy guide chain follows the movement of the sliding door, which is not along a straight line. The invention is especially for sliding door systems which are suitable

for being used in vehicles. However, this is not absolutely necessary. The fundamental ideas of the invention can be used also in other sliding door systems, for example, in gate systems. The invention also makes it possible to enable subsequent incorporation into sliding door systems in a cost-effective manner. The energy guide chain can also be designed differently. It can consist of individual chain links which are linked together pivotably. It is also possible to build the energy guide chain through segmented strands. The radius of curvature  $KR$  can also be varied with different designs of the stops.